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# Irrigation Guide

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# Irrigation Guide

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# IRRIGATION GUIDE

(outline)

PART I

A. Inventory of Resources

1. Water

a. Locating a suitable supply
b. Quantity needed
c. Quality
d. Water permit

2. Soil

a. Soil type
(1) drainability
b. Topography

B. Methods of Irrigation

1. Gravity irrigation

a. Distributing the water
(1) Gated pipe
(2) Open ditch--Siphon tube
b. Applying the water
(1) Basins
(2) Borders
(3) Corrugations
(4) Furrows
(5) Controlled flooding
c. Irrigation machinery and equipment
d. Land development

2. Sprinkler irrigation

a. Adaptability
b. Types
(1) Hand-move
(2) Tractor-pull
(3) "Whirlybird"
(4) Self-propelled

C. Pumping Equipment

1. Pumps

2. Power

   a. Requirement
   b. Selecting a power unit

D. Economics of Irrigation

1. Estimating initial cost of irrigation

   a. Well
   b. Centrifugal pumping units
   c. Turbine pumping units
   d. Land development
   e. Machinery and equipment for gravity irrigation
   f. Sprinkler irrigation equipment

2. Estimating annual cost of irrigation

   a. Fixed costs
   b. Operating costs
      (1) Pumping costs
      (2) Land preparation for gravity irrigation
      (3) Labor requirement for irrigation
   c. Additional costs

3. Examples in estimating annual cost of irrigation

   a. Gravity system--siphon tubes
   b. Sprinkler system--tractor-pull

4. Range of annual cost of pump irrigation for various irrigation methods

5. Anticipated production with irrigation

6. Feasibility of irrigation

# IRRIGATION GUIDE*

## PART I

### A. Inventory of Resources

#### 1. Water

##### a. Locating a suitable supply

The only major surface water supply available for irrigation in South Dakota is the Missouri River. Most of the other surface waters are either over-appropriated or are not too dependable.

In some areas, ground water supplies exist in sufficient quantity and of suitable quality for irrigation. These areas are principally outwash plains found in the eastern part of the state. General information on these areas can be obtained from either the State Geological Survey at Vermillion or the U. S. Geological Survey at Huron. A program of test drilling should accompany any attempt to locate and use a ground water supply for irrigation.

##### b. Quantity

The rate of flow of water required for an irrigation system will depend on the peak moisture use rate of the crop being irrigated and on the efficiency of water application.

For most crops and conditions encountered in South Dakota, the peak moisture use rate can be considered as 0.25 inches per day. Based on a water application efficiency of 70%, which is possible for any well designed system, a continuous flow of 6-1/2 gallons per minute per acre to be irrigated will be needed.

With this starting point of 6-1/2 gpm per acre, the following factors should be taken into consideration when making recommendations to a farmer:

(1) Number of hours per day irrigation system will be in operation. The above is based on a 24-hour day.

(2) Time between irrigations, which is a function of the soil's water-holding capacity and the likelihood of rainfall.

*Martin Fogel, Extension Irrigation Specialist, Dr. L. O. Fine, Head of Agronomy Department, F. F. Kerr, Water Resources Specialist.

The shorter the irrigation interval, the less the chance of rain and the greater the opportunity for hot-drying weather. Irrigation on lighter soils should be increased by about 10%.

(3) The use of more than one crop each of which has a peak moisture requirement occurring at a different time of the growing season. For example, grain will have its peak requirement earlier than corn.

(4) The use of off-season irrigation to store moisture in the soil. This is a decided advantage in the medium and heavy soils.

CONCLUSION--A continuous flow of 7 to 9 gallons per minute will be needed to obtain a high level of production from each acre to be irrigated. This can be reduced by about 25% on the medium and heavy soils where off-season (spring or fall) irrigation is possible.

c. Quality

All irrigation waters contain dissolved salt. It is extremely important that a potential irrigation water supply be tested to determine its quality. A water-quality test can alert the farmer to two hazards:

(1) The presence of salinity

(2) The possibility of the formation of a sodium (alkali) soil

Most of South Dakota's water is of high salinity. This indicates that all water should be tested before using it for irrigation.

Water can be tested by sending a one quart sample to the Soils Testing Laboratory at State College.

When the "Report of Water Analysis" is returned it will bear one of the following classifications:

(1) Excellent to good

(2) Good to permissible

(3) Permissible to doubtful

(4) Doubtful to unsuitable

(5) Unsuitable

Classification 5 water should not be used for irrigation. Classifications 3 or 4 might be used if internal and surface drainage are both good. If classes 3 or 4 are used, periodic soil tests to the depth of the root zone should be made to determine whether or not salts are accumulating.

d. Water Permit

Before any construction takes place (such as drilling a well) or any irrigation equipment is purchased, a water permit should be obtained from the State Water Resources Commission at Pierre.

Briefly an application for a water permit includes:

(1) Completed forms (blanks can be obtained from the Water Resources Commission).

(2) A map prepared by a Registered Land Surveyor (including certain authorized personnel in the SCS) which shows the number of acres to be irrigated and the location of the diversion point (the pump in most cases) with respect to a government corner, such as a section corner.

(3) A fee of $8.00

Upon receipt of the application, it is given a priority date. This priority date does not guarantee the applicant water, but that he has a prior claim to its use to any subsequent application.

The applicant then has a maximum of 5 years to complete the construction (or purchase equipment). However, in half the time he has applied for, he must have completed 20 per cent of the construction.

When the construction of the irrigation system is completed, he has an additional 4 years to prove that he has put the water to "beneficial use." Thereafter, he must irrigate each acre applied for at least once every three years to keep his right.

2. The Soil

The two basic resources--water and soil--must be combined by the farmer in a manner conducive to good plant growth before irrigation can become a success. Although water can be modified slightly to change the quality, the soil can perhaps be changed even more to make a suitable environment for plant growth. However, the extent to which we are willing to modify both soil and water is conditioned quite largely by the economics of the situation and the labor we are willing to expend.

a. Soil Type

The ideal soil to irrigate would perhaps be a medium-textured, high organic content soil about 5 feet thick, underlain by a

gravel or sand layer which has unrestricted drainage to a natural waterway. The texture could range from a sandy loam to a silt loam. Starting from this as an ideal, we can accommodate many less desirable types to irrigation, provided the financial incentive is large enough to justify the cost of the necessary installations and management practices to make it a physical success. Actually, soil types ranging from heavy clays to pure sand are irrigated successfully under various circumstances.

(1) Drainability

Internal drainage is absolutely essential to prevent waterlogging and salt accumulation.

The most important single physical characteristic of soils considered for irrigation is their drainability. This property is the most expensive one to alter, if naturally unsatisfactory. The elements of drainability which must be naturally present, or acquired by artificial means are: (1) permeability of the soil (ability of the soil to transmit water) both vertical and horizontal; (2) the presence of a conducting vehicle such as a sand or gravel layer below the soil to remove the water, or else a subsoil to great depths; and (3) an outlet for the drainage water from such a conducting vehicle.

Regarding the permeability of the soil itself, no hard and fast boundaries can be set, but any soil transmitting less than 0.02 inches per hour will give difficulty. The measures which the farmer can use to improve the permeability are: (1) the addition of organic matter; (2) the growing of deep-rooted grasses and legumes; and (3) the addition of gypsum to those soils having a high sodium content in the clay fraction.

Regarding a conducting vehicle: The vehicle to remove drainage water, if sand or gravel is not present, very likely a tile system or an open drain system will have to be installed as an artifical aqueduct, since there are no areas in South Dakota which have an infinitely deep, permanently dry subsoil. The tile installation can often be the most expensive part of the whole land development operation. In fine-textured soils, the cost can exceed $200 per acre.

The third element--a drainage outlet--must be established before tile installation begins. This is often a creek or river channel, an intermittent stream bed or a natural depression or drainageway leading to a stream. In a large area being developed for irrigation, the problem of a drainage outlet is usually simply that of hooking on to a main tile. In those cases where gravel or sand underlie the soil, natural seepage into channels which intersect the aquifer often take care of drainage very satisfactorily. Occasionally, however, this seepage is blocked, and artificial means of draining the aquifer, such as pumping or deep channeling, must be used.

In this discussion, it is assumed that surface drainage is established in the land leveling process, or occurs naturally. Occasionally outlet ditches for excess surface waters will need to be built connecting with the nearest natural drainageway. In sprinkler application, it is seldom necessary to make any provision for surface drainage, inasmuch as the system is designed to apply water at a rate somewhat less than the infiltration rate of the soil.

It is impossible to judge the drainability of a piece of land without specific knowledge of the above three factors. However, certain soil types and associations are characteristically very slowly permeable, and therefore difficult or nearly impossible to drain. If, in addition, the soil parent material itself, below the soil proper but in contact with it, is salty enough to offset plant growth, the prospects are indeed poor. As soon as water contacts the saline substratum, evaporation from the surface begins a movement of salt to the upper part of the soil profile, and plants experience increasing difficulty in growing as the salt increases. The Exline, Cavour, Aberdeen, Pierre, Orman and Rhoades soils are the extreme examples of this situation in South Dakota. These soils all have low permeability and usually saline substrata. Some of the soils of somewhat better permeability, such as Harmony and Houdek, occasionally have saline substrata.

b. Topography

The topography or "lay of the land" is an all-important factor in choosing between surface methods of "gravity" irrigation and sprinkler irrigation. There are practical limits beyond which one cannot go in preparing rough or uneven land for gravity irrigation. The cost of earth moving and land leveling can become prohibitive, and the topsoil can be buried beyond reach of plant roots, with the accordant loss of physical and fertility factors so essential to good crop growth. Land which has short, complex slopes (in more than one direction) and slopes exceeding 7 or 8%, can seldom be surface irrigated, except for pasture or hay, without certain special practices. Contour irrigation and permanent concrete drops in head ditches are almost a <u>must</u> in areas having slopes of 5 to 8%. Even land of 2 to 5% slope requires severe leveling for gravity irrigation if the slopes are short and complex. Of course, where high value crops are produced, such as truck, long staple cotton, fruits, and seed crops, the investment in head ditch structures and contour irrigation, even on land of 12 to 15% slope, is easily justified. The reader is referred to the land classification standards of the U. S. Bureau of Reclamation for the exact topographic limits of each land class. These standards set forth the yardage of earth which can be moved within any one land class, as well as the slope tolerance.

As indicated earlier, the extent of land moving one should consider, and the ultimate decision between gravity and sprinkler irrigation, as will be discussed later, are largely conditioned by the type of crops to be irrigated. Pasture and hay crop irrigation, as well as grasses and alfalfas for seed, and certain truck crops, may often be irrigated as advantageously by sprinkler as by gravity, and under adverse topographic conditions at a far lower cost. Again, the decision cannot be made by anyone but the irrigator, and no arbitrary guides set forth in this publication should serve as hard and fast rules for any specific piece of land.

3. Labor

Irrigation intensifies the labor requirement for raising crops. More labor will be needed for the actual job of irrigating, for land preparation in the case of gravity irrigation, for additional tillage and harvesting operations and for additional weed, pest and disease control. The following table, based on information found in South Dakota Agricultural Experiment Station Bulletin 444, "Economic Potentials of Irrigated and Dryland Farming in Central South Dakota," presents the labor requirement for some crops:

| | Labor requirement man-hours per acre | |
|---|---|---|
| Crops | Dryland | Irrigated* |
| Alfalfa | 9 | 13 |
| Corn | 3 | 13 |
| Small grains | 1 1/2 | 6 |
| Pasture | - | 4 |
| Potatoes | - | 15 |
| Sugar Beets | - | 32 |

*For gravity irrigation

In the case of alfalfa, most of the additional labor requirement with irrigation is due to the time spent in irrigating and in harvesting a larger tonnage. This is not necessarily true where corn is raised under gravity irrigation. This method of irrigation requires some land preparation over and above that needed for dryland farming. Fields have to be smoothed and ditches put in before corn can be irrigated. This is the reason for the greater spread in labor requirement between dryland and irrigated farming. The labor requirement for applying the water and land preparation costs will be discussed in a later section under economics of irrigation.

B. Methods of Irrigation

1. Gravity Irrigation

If the choice in selecting a method of irrigation is based solely on economic factors, a gravity system will be selected in practically all cases provided the physical conditions are suitable. Conditions which will normally preclude using the gravity method are:

- small flow of water (less than 1 cfs or 450 gpm)
- porous soils, especially those underlain with gravel at shallow depths
- rolling or complex topographic pattern

a. Distributing the Water

There are two main types of distribution systems, the gated pipe and the open ditch--siphon tube systems.

(1) Gated Pipe

Gated pipe is more flexible than the siphon tube-open ditch method in that the source of water need not be at the highest point of the land. The length of run is also more readily adjusted with gated pipe. Other advantages are that there are no water losses and weed problems in ditches. Also, gated pipe can be used as a mainline in combination gravity and sprinkler systems.

(2) Open Ditch--Siphon Tube

This is the cheapest method for distributing water for a gravity irrigation system in both first and annual costs.

b. Applying the Water

(1) Basins

Adapted to close-growing crops. Provides good control of water applied. Good for alkali control.

(2) Borders (Leaflet 297 USDA--Border Irrigation)

Adapted to hay or grain on uniform slopes up to 2% and on established pasture up to 5%. Best adapted to medium and light soils.

Provides uniform wetting and efficient water use. Utilizes large water streams and thus less time is required to cover area.

(3) Corrugations (Leaflet 343 USDA--Corrugation Irrigation)

Adapted to close-growing crops on sloping land with soil slow to take water. Extreme care is needed in applying water to slopes of more than 2%.

Provides fairly uniform wetting and prevents erosive water accumulation on land too rolling or steep for borders or basins. Makes use of small streams.

(4) Furrows (Leaflet 344 USDA--Furrow Irrigation)

Adapted to row crops on gentle slopes (1 to 2% or less) on all but the coarse-textured soils.

Provides fair water application efficiency. Water should be applied down each furrow at a non-erosive rate.

(5) Controlled Flooding

Adapted to close-growing crops. Provides water control and fairly uniform wetting where land cannot be used for other methods.

c. Irrigation Machinery and Equipment

The following is a list of the more common items of irrigation machinery and equipment, not all of which will be needed on a given farm, and their approximate cost:

Leveler--$600 to $1200, Depends on size, type of controls (hydraulic or mechanical) and on additional devices such as for making borders

Ditcher--$300 to $500, Depends on size, model, controls, etc.

Corrugator--$100

Two-Way Plow--$600

Siphon Tubes, Dams, etc.--$3 per acre

Furrow-Openers--$100 to $200, Cost will vary on equipment used. Can use special equipment or 8 or 10-inch lister shovels mounted on a tool bar.

d. Land Development

Preparing land for gravity irrigation requires surface grading (or land leveling), installation of farm laterals and drains and water control structures such as checks, drops, turnouts, etc. The cost for such development will vary considerably. A good example of what these costs might run can be found in the Bureau of Reclamation estimates for land development in the Oahe area. They have estimated that full development of all the irrigable land will be about $65 per acre. The first lands on a given farm that are brought under gravity irrigation will normally be much less than this figure. Experience has shown that initial land development on a farm will be about 1/2 to 2/3 the Bureau of Reclamation estimate or about $20 to $40 an acre. Subsequent development will usually be higher than this.

2. Sprinkler Irrigation

Where gravity irrigation is not suitable or preferred, sprinkler irrigation can be a profitable practice in South Dakota.

a. Adaptability

A principal advantage of sprinkler irrigation is its flexibility. It can be used on practically all crops and on all land suitable for irrigation. Its flexibility is also demonstrated by the fact that a system can be "stretched" to cover more acres with very little additional expense. This is done with the use of such practices as off-season irrigation to store water in the soil and the use of crops that have peak water requirements occurring at different times of the growing season. Another advantage is that it is readily installed and requires an easily attained skill to operate.

Its main disadvantages are a greater fuel or power cost than for gravity irrigation and a higher fixed cost (depreciation, interest, etc.).

b. Types of equipment

(1) Hand move

Until recently, the only way to move sprinkler pipe was to carry it. While not too difficult when used on close-growing crops, irrigating tall corn presented a problem.

(2) Tractor-Pull

Sprinkler laterals up to 1/4 mile in length are pulled by a tractor from one position to another. The pipe is usually skidded along the ground on special skid sleds. Special field arrangements of crops are generally needed. For example, the mainline is laid in a 150 to 200 foot center strip of alfalfa. On each side of this strip, alternating strips of 16 rows of corn and 4 rows of a low growing crop such as milo, soybeans, or alfalfa are planted. Thus, in a 80-acre field only 58 acres may be planted to corn. The pipe is skidded into the low-growing strips, as shown by the arrows in the illustration on page 10a.

(3) "Whirlybirds"

To irrigate corn, a revolving boom mounted on a trailer has been developed. This device is commonly called a "whirlybird." The "whirlybird" moves across a field in 240 to 330-foot strips in paths 2 to 4 rows wide. These "paths" can be planted to milo, soybeans, alfalfa or similar crops. Labor is reduced but operating pressures (thus power requirements and power costs) are increased.

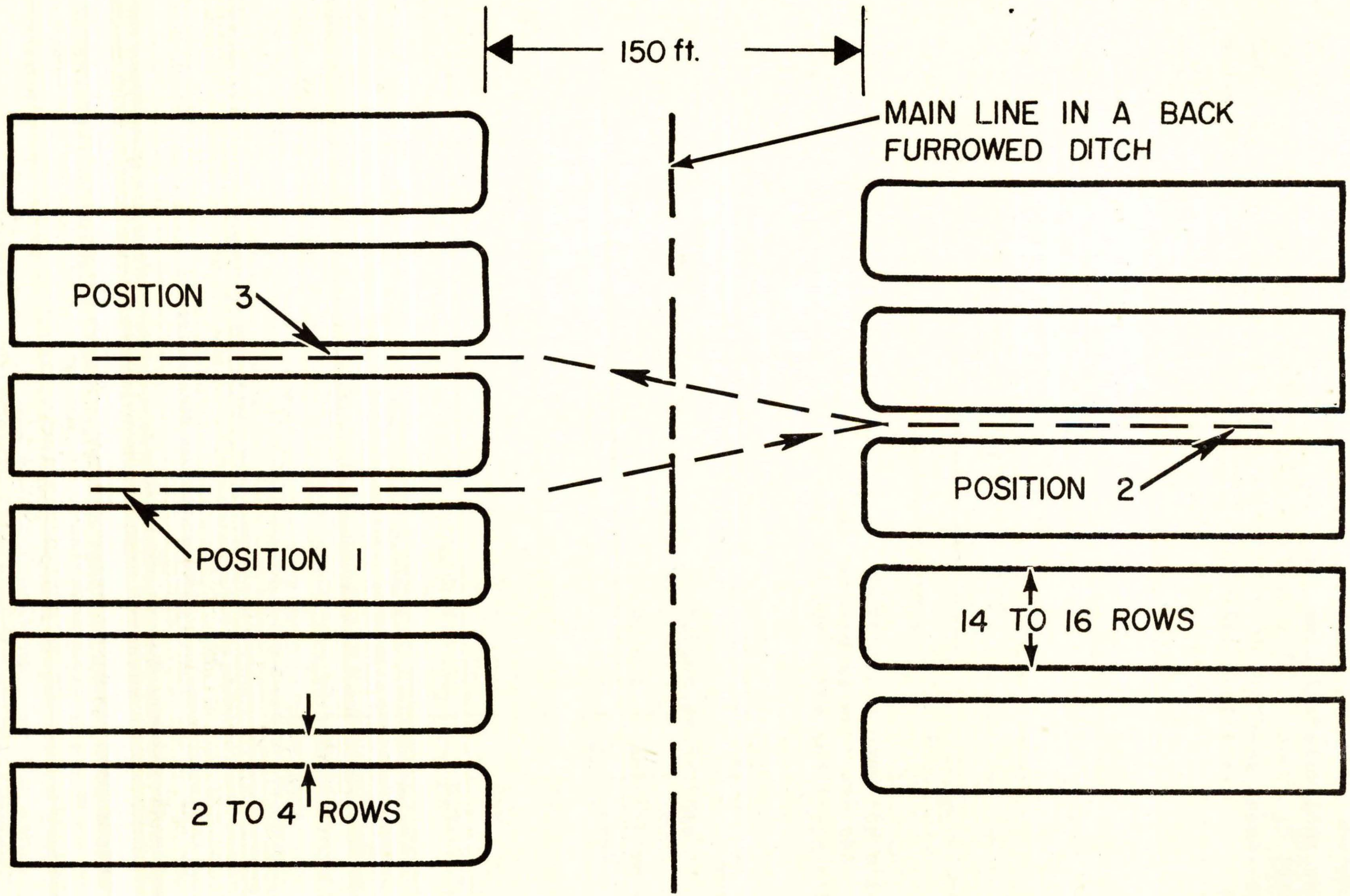
(4) Self-Propelled System

A self-propelled sprinkler irrigation system in which pipe is mounted on "A" frames which pivot about a central point is another recent innovation. The pipe with sprinklers travels slowly around the field automatically irrigating about 90% of the field. Labor is further reduced (generally all that is needed is to move from one field to another) but initial cost and operating pressures are high.

C. Pumping Equipment

1. Pumps

Irrigation pumps in South Dakota are usually either of the horizontal centrifugal type or the deep-well turbine type. In some instances, a mixed flow or propeller pump may be used where large quantities of water are pumped against low heads.


150 ft.
MAIN LINE IN A BACK FURROWED DITCH
POSITION 3
POSITION 2
POSITION 1
14 TO 16 ROWS
2 TO 4 ROWS

Turbine pumps are used in practically all well installations as centrifugal pumps are limited to a suction lift of about 15 feet. Centrifugal pumps are used to lift water from streams, lakes, stock ponds, ditches, and other surface water supplies.

2. Power

a. Requirements

The actual power required to operate a pump is known as brake horsepower (BHP), the formula for which is:

$$BHP = \frac{\text{GPM x total head in feet}}{\text{3960 x pumping plant efficiency}}$$

For estimation purposes, a figure of 70% is often used for plant efficiency. The following table can be used to estimate the horsepower required per 100 GPM for various lifts and irrigation systems:

Horsepower required per 100 GPM pumped

| Lift in Feet | Gravity Systems | | Sprinkler Systems | |
|---|---|---|---|---|
| | Open Ditch | Gated Pipe | Hand Move & Tractor Pull | Whirlybird & Self-Propelled |
| 10 | 0.4 | 1.3 | 4.6 | 7.6 |
| 20 | 0.8 | 1.7 | 5.0 | 8.0 |
| 40 | 1.6 | 2.5 | 5.7 | 8.7 |
| 60 | 2.3 | 3.2 | 6.3 | 9.4 |
| 80 | 3.0 | 3.9 | 7.0 | 10.1 |
| 100 | 3.7 | 4.6 | 7.8 | 10.9 |

b. Selecting a Power Unit

In selecting an internal combustion engine power unit, one should be chosen whose horsepower rating is 50 to 60% greater than the horsepower required to operate the pump (figures shown above). For example, an 800 gpm gated pipe system is to be used where the lift is 40 feet. Horsepower required equals 8 x 2.5 or 20 hp. Select an engine that has a minimum rating of 30 hp. (50% greater than 20 hp.). While a 20 hp. electric unit will do the above job, in many conditions a 25 hp. unit (the next size larger motor) might be preferable.

## D. Economics of Irrigation

### 1. Initial cost of irrigation

The following cost estimates are intended to be used as a guide only:

a. Water Supply

- Well, complete with casing, developing and testing: $15 to $20 per foot.

b. Centrifugal pumping units for surface water installations:

| Required HP | Pump, 3-phase motor, and controls | Pump, Water-cooled engine | Pump, Diesel engine |
|---|---|---|---|
| 10 | $ 600 | $1200 | $2000 |
| 20 | 1000 | 1600 | 2500 |
| 30 | 1400 | 2000 | 3500 |
| 40 | 1800 | 2400 | 4500 |
| 50 | 2200 | 2800 | 5500 |
| 75 | 2800 | 3200 | 6500 |
| 100 | 4000 | 4000 | 7500 |

c. Turbine pumping units for well installations with 100' pump setting. (Add or subtract $10 per foot for pump setting other than 100')

| Required HP | Pump, 3-phase motor, and controls | Pump, gear head Water-cooled engine | Pump, gear head Diesel engine |
|---|---|---|---|
| 10 | $2000 | $2500 | $3500 |
| 20 | 2500 | 3000 | 4000 |
| 30 | 3000 | 3500 | 4500 |
| 40 | 3500 | 4000 | 5500 |
| 50 | 4000 | 4500 | 6500 |
| 75 | 4500 | 5500 | 8000 |
| 100 | 5500 | 6500 | 9000 |

d. Land development, including land grading (or leveling), farm laterals and drains, water control structures (drops, checks, turnouts, etc.): $25 to $75 per acre.

e. Machinery and equipment for gravity irrigation:

| | |
|---|---|
| Leveler, 9-foot, hydraulic controls ......... | $1000 |
| Ditcher .................................... | 400 |
| Furrow-openers ............................. | 200 |
| Two-way plow ............................... | 600 |
| Corrugator ................................. | 100 |
| Border-making device ....................... | 300 |
| Siphon tubes and dams ...................... | 3 per acre |
| Aluminum gated pipe, (30' pipe lengths) | |
| 6" ......................... | 1.20 per foot |
| 8" ......................... | 1.70 per foot |
| 10" ......................... | 2.30 per foot |

f. Sprinkler irrigation equipment

Mainline (class 150 pipe), 30' pipe lengths:

5"......$1.20 per foot
6"...... 1.60 per foot
7"...... 2.05 per foot
8"...... 2.60 per foot

Hand-move lateral lines (class 150 pipe) including sprinklers, 30' pipe lengths:

3"......$1.00 per foot
4"...... 1.20 per foot
5"...... 1.50 per foot

Tractor-pull lateral line including sprinklers, 30' pipe lengths:

3"......$1.20 per foot
4"...... 1.40 per foot
5"...... 1.75 per foot

"Whirlybird" (60-80 acres per unit)..........$1500

Self-propelled sprinkler line:

40 acre unit (40-rod line)............... 7000
160 acre unit (80-rod line).............13,000

2. Annual Cost of Irrigation

a. Fixed costs

Includes depreciation, interest on investment, insurance and taxes.

To obtain the estimated fixed cost per year, multiply the initial cost of the item by the fixed cost rate shown in the following table:

| Item | Fixed Cost Rate (%) |
|---|---|
| Well | 14 |
| Pumping Unit: | |
| Electric | 8 |
| Diesel | 11 |
| Propane | 12 |
| Gasoline | 14 |
| Water Control Structures: | |
| Wood | 24 |
| Concrete | 9 |
| Irrigation machinery (leveler, ditcher, two-way plow, furrow-openers, corrugators and border-making device) | 12 |
| Siphon tubes and portable dams | 24 |
| Aluminum gated pipe | 10 |
| Sprinkler equipment: | |
| Mainline and hand move | 10 |
| Mechanical moves (tractor pull, whirlybird, self-propelled) | 14 |

b. Operating Costs

(1) Pumping Costs

There are several ways of estimating the cost of operating a pumping plant. The following table presents one method:

| Type of Power Unit | Unit Cost for Fuel or Power | Operating Cost per Acre-Foot per Foot of Total Head |
|---|---|---|
| Electric | $0.02 per KWH | 3 1/2¢ |
| Diesel | 0.16 per gal | 3 1/4¢ |
| Gasoline | 0.20 per gal | 4 1/2¢ |
| Propane | 0.12 per gal | 3 1/2¢ |

The above costs are for fuel or power, lubrication and repairs.

The following table gives average discharge heads for various irrigation systems to which must be added lift in feet to obtain total head:

| Irrigation System | Discharge Head in Feet |
|---|---|
| Open ditch | 0 |
| Gated pipe | 25 |
| Hand-move | 115 |
| Tractor-pull | 115 |
| Whirlybird | 200 |
| Self-propelled | 200 |

(2) Land preparation for gravity irrigation

These items include primarily the use of the farm leveler and ditcher. The following takes into account labor and tractor time for these and other operations:

Open ditch ........ $3 per acre per year
Gated pipe ........ $2 per acre per year

(3) Labor Requirement for Irrigation

The following table gives the man-hours per acre in applying water at each irrigation:

| Irrigation Method | Crop | Man-Hours per acre per Irrigation |
|---|---|---|
| Gravity: | | |
| Siphon tubes | corn | 1.0 |
| | alfalfa | 0.7 |
| Gated pipe | corn | 0.8 |
| | alfalfa | 0.6 |
| Sprinkler: | | |
| Hand-move | corn | 1.5 |
| | alfalfa | 1.0 |
| Tractor-pull and Whirlybird | corn | 0.6 |
| | alfalfa | 0.5 |
| Self-propelled | corn | 0.2 |
| | alfalfa | 0.2 |

c. Additional Costs of Irrigation

Additional costs over and above dryland costs involved with irrigation include the following:

Additional seed
Additional fertilizer
Additional weed and pest control
Additional tillage and harvesting operations

These costs will average $5 to $10 per acre for most field crops (corn, alfalfa and small grains) irrigated on a given farm. For specialty crops such as potatoes and beets these additional costs will be much higher.

3. Examples in Estimating the Annual Cost of Irrigation

a. Gravity Irrigation--Open Ditch

Water supply
Well: depth, 100'
lift, 60'
capacity, 800 gpm
Acreage to be irrigated--80 acres corn

Hours of operation:

Assume three 6 inch irrigations per year
Total water pumped per year = 3 x 6 x 80 = 1440 acre-inches
= 120 acre-feet
Pump capacity is 800 GPM and 450 GPM = 1 acre-inch per hour so 800/450 = 1.78 acre-inch per hour
hours/year = 1440/1.78 = 810

Power requirement:

2.3 hp. per 100 gpm. (from table on page 11)
8 x 2.3 = 18.4 hp.
Use 20 hp. electric motor or 28 hp. internal combustion engine

Probable investment:

| | | |
|---|---|---|
| Well ................................ | $1500 | (see page 12) |
| Turbine pumping unit with 20 hp. electric motor................... | 2500 | (see page 12) |
| Leveling ($35 per acre) ........... | 2800 | (see page 13) |
| Leveler, ditcher, and furrow openers | 1600 | (see page 13) |
| Siphon tubes and dams.............. | 240 | (see page 13) |
| Water control structures (wood).... | 100 | |
| TOTAL...... | $8740 | |

Annual fixed costs:

| | |
|---|---|
| Well, 14% of $1500.................. | $ 210 |
| Pumping unit, 8% of $2500.......... | 200 |
| Leveling, 4% of $2800.............. | 102 |
| Leveler, ditcher, furrow openers, 12% of $1600.................... | 192 |
| Siphon tubes and dams, 24% of $240. | 58 |
| Water control structures, 24% of $100.......................... | 24 |
| TOTAL...... | $ 786 |

Annual operating costs:

Pumping (60' head)
$0.035 x 60 = $2.10 per acre-foot (see page 15)

| | |
|---|---|
| 120 acre feet x $2.10 per acre-foot (based on electricity @ 2¢ per KWH)............ | $ 252 |
| Land preparation @ $3 per acre.................... | 240 |
| TOTAL...... | $ 492 |

Total annual cost of irrigation .................. $ 1278
Total annual cost per acre ....................... 16
Plus a labor requirement of 3 man-hours per acre and additional costs. (see page 16)

Assuming a $1 per hour labor charge and additional costs of $8 per acre, the cost of production under irrigation will be higher than for dryland farming by $27 an acre.

b. Example of Sprinkler Irrigation: Tractor-pull

Water supply, Well: depth, 100'
lift, 60'
capacity, 600 gpm
Acreage to be irrigated--80 acres

Hours of operation:

Assume four 4" irrigations per year
Total water pumped per year = 4 x 4 x 80 = 1280 acre-inches
= 107 acre-feet
450 GPM = 1 acre inch per hour, so
600/450 = 1.33 acre inches per hour
hours /year = 1280/1.33 = 960

Power requirement:

6.3 hp. per 100 gpm. (see page 11)
6 x 6.3 = 37.8 hp.
Use 40 hp. electric motor or 57 hp. internal combustion engine

Probable investment:

| | | |
|---|---|---|
| Well................................ | $1500 | (see page 12) |
| Electric pumping unit ............ | 3500 | (see page 12) |
| Mainline, 40 rods, 6"............. | 1000 | (see page 13) |
| Lateral line, 160 rods, 4" ....... | 3500 | (see page 14) |
| TOTAL... | $9500 | |

(Note: If well is in center of quarter section, by adding 40 rods of mainline, 160 acres can be reached with system.)

Annual fixed costs: (see page 14)

| | |
|---|---|
| Well, 14% of $1500 .............. | $ 210 |
| Pumping unit, 8% of $3500 ....... | 280 |
| Mainline, 10% of $1000 .......... | 100 |
| Lateral line, 14% of $3500 ...... | 490 |
| TOTAL.. | $1080 |

Annual operating costs: (see page 15)

Pumping
Total head = 60 + 115 = 175 feet
$0.035 x 175 = $6.13 per acre-foot
107 x 6.13 = .................................... $ 656
TOTAL...... 656

Total annual cost of irrigation .................. $1736
Annual cost per acre ............................ 22
Plus a labor requirement of 2 man-hours per acre and additional costs. (see page 16)

(Note: If above system were used on 160 acres, 80 during growing season and 80 during off season, annual cost would drop down to about $16 per acre.)

Assuming a $1 per hour labor charge and additional costs of $8 an acre, irrigation in this case will add $32 an acre to the dryland cost of production.

4. Range of Annual Cost of Pump Irrigation for Different Irrigation Methods:

| Irrigation Method | Annual Cost of Irrigation per Acre* |
|---|---|
| Gravity | |
| Open ditch | $ 12 to 18 |
| Gated pipe | 14 to 20 |
| Sprinkler | |
| Hand-move | 15 to 25 |
| Tractor pull | 15 to 25 |
| "Whirlybird" | 20 to 30 |
| Self-propelled | 25 to 35 |

*Includes fixed and operating costs, but not for labor or additional costs.

5. Anticipated Production with Irrigation

The following table presents per acre yield goals for various irrigated crops for soils throughout the state with no serious soil restrictions (unfavorable texture, depth, structure or topography) and for those soils having serious soil restrictions.

| Crop | Easily Tilled (Friable Soils) | Other Soils |
|---|---|---|
| Corn (bu/ac) | 80-120 | 70-90 |
| Alfalfa (tons/ac) | 5-7 | 4.5-6.0 |
| Oats (bu/ac) | 80 | 70 |
| Barley (bu/ac) | 50-75 | 35-50 |
| Wheat (bu/ac) | 40 | 30 |
| Soybeans (bu/ac) | 30-40 | 20-30 |
| Potatoes (bu/ac) | 400-600 | 300-500 |
| Sugar beets (tons/ac) | 18-25 | 15-20 |
| Sorghum (bu/ac) | 75-100 | 60-80 |

6. Feasibility of Irrigation

There are several methods of determining the feasibility of irrigation. One is to compare the increased cost of production due to irrigation with the value of the increased production. For example, assume corn yields are increased 50 bushels per acre with an additional expenditure of $30 an acre because of irrigation. If the corn is valued at $1 per bushel, the net return to irrigation is $20 per acre.

Another way would be as follows:

| | Irrigated | Dryland |
|---|---|---|
| Yield of corn | 75 bu/ac | 25 bu/ac |
| Value @ $1 per bushel | $75/ac | $25/ac |
| Cost of production | $50/ac | $20/ac |
| Returns | $25/ac | $ 5/ac |
| Cost per bushel | $0.67 | $0.83 |